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The external morphology of *Chrysopa perla* L. (Neuroptera: Chrysopidae)

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The External Morphology of *Chrysopa perla* L.
(Neuroptera : Chrysopidae)

Miriam Morse

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THE EXTERNAL MORPHOLOGY OF CHRYSOPA PERLA L.

(Neuroptera: Chrysopidae)

Miriam Morse

A thesis submitted in partial
fulfillment of the requirements
for the Degree of Master of Science.

Massachusetts Agricultural College
Amherst, Mass.

1930.

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INTRODUCTION

The purpose of this thesis is to make a complete morphological study of a typical Chrysopid with the hope of finding morphological characters which may be used as a basis for future systematic work on the group. Color and wing venation have been largely used in the group for specific differences, but many of the present taxonomists find that body morphological characters are of more value for systematic work.

The Palaearctic Chrysopa perla L. was selected for two reasons; first, it is typical of the family and, second, the sutures demarking the sclerites are more distinct than in any of the native species.

Dr. G. C. Crampton furnished the material which he collected in Norway. The writer was also very fortunate in securing from Staudinger and Bang-Haas, Germany, eight specimens of Chrysopa perla, three of which were determined by L. Navás.

ACKNOWLEDGMENTS

The writer wishes to express her sincere acknowledgment to Dr. G. C. Crampton, not only for the material furnished, but also for his suggestions, help and criticism in the morphological study; to Dr. C. P. Alexander for the assistance he has given in the venational study; to Dr. H. T. Fernald for his kindly interest and suggestions; and to Dr. Nathan Banks of the Museum of Comparative Zoölogy at Harvard for advice on the nomenclature of Chrysopa perla.

HISTORY

Linnaeus (1758) described Hemerobius perla as "H. viridis, alis hyalinis: vasis viridibus". Leach (1815) made a new genus Chrysopa in which he placed H. perla and put this genus in a new family Hemerobida. Westwood (1840) designated perla as the genotype of Chrysopa. Schneider (1851) divided Hemerobidae into three divisions and placed Chrysopa in Chrysopina. Hagen (1866) made Chrysopidae a subfamily of Hemerobidae and in so doing made Chrysopa the type genus. MacLachlan (1868) raised Chrysopidae to the rank of family. The various stages in our knowledge of this subject may be shown by the accompanying table.

Linnaeus 1758	Phryganea Hemerobius perla	Hemerobius perla described
Leach 1815	Hemerobida Chrysopa perla	Chrysopa became a genus
Westwood 1840	Hemerobiidae Chrysopa perla	Chrysopa perla became the genotype
Schneider 1851	Hemerobidae Chrysopina Chrysopa perla	Chrysopina designated as a division

Hagen 1866	Hemerobidae Chrysopidae Chrysopa perla	Chrysopidae designated as a subfamily; Chrysopa became the type genus
MacLachlan 1868	Hemerobiina Chrysopidae Chrysopa perla	Chrysopidae raised to family rank

The chief workers on the group are: Banks (1909), Brauer (1850), Hagen (1861, 1866), MacLachlan (1868), McDunnough (1909), Navás (1925), Pariser (1919), Petersen (1927), Pongrácz (1919), Schneider (1851), Smith (1922), Stitz (1927?), Tichomirowa (1892), Tillyard (1916) and Withycombe (1922).

DISTRIBUTION

Chrysopa perla has a wide range in Eurasia, being found in Great Britain, throughout continental Europe as far north as Scandinavia and Finland and south to Hungary, and in central Siberia.

GENERAL APPEARANCE

Chrysopa perla as compared with other members of the family is of medium size. There is, however, noticeable variation of size within the species. In general its color is blue green. The longitudinal veins of the wings are green while the greater number of the cross-veins are dark brown. The head is yellowish-green with a dark brown spot on the gena and each side of the clypeus. Between the antennae is an X-shaped marking which is continued on top of the head as a forked band, the arms of which meet a transverse band at the back of the head. The antennae which are shorter than the wings are a pale reddish-brown; the basal segment is yellowish-green with brown at the proximal end; the second segment is dark brown with light brown edges. The thorax is green, with two dark brown spots on each side of the prothorax and dark symmetrical spots on the meso- and metathorax. The legs are green. The pleurites of the abdomen are dark green, while the tergites and sternites are dark brown with green edges.

EXTERNAL MORPHOLOGY

Head and Its Appendages

The head, from the frontal aspect, is somewhat circular in outline, arching slightly at the vertex. There are no sexual characters on the head. Most of the sutures

which in many insects demark the various sclerites of the head capsule are absent in Chrysopa perla. Thus as the sclerites are not distinctly separated, the names in most cases apply merely to areas in general rather than to clearly defined parts.

Head capsule (Pl. I, fig. 4, 8):- The areas making up the head capsule are the occiput, vertex, frons, genae, postgenae, gula, clypeus, and labrum.

The occiput (ocp) is the caudal portion of the head dorsad of the occipital foramen (for). The occipital foramen is the posterior opening in the head capsule through which the alimentary canal, nervous system and other organs pass back into the thorax.

The frons (fr) and vertex (v) occupy the dorsal area of the head. The vertex is slightly arched dorsally and, from a frontal aspect, appears as a large median lobe, with a smaller one on each side which extends to the dorsal margin of the eyes. The temporal sutures (ts) extend forward from the occipital suture (os) and demark the temporal regions. The epicranial suture present in many insects demarking the frons and vertex is lacking, thus causing these regions to appear as one area. The frons is bounded laterally by the frontal sutures (fsu) and anteriorly by the epistomal suture (esu).

The frontal pits (frp) lie in the anterior portion of the frontal sutures. They are clearly defined depressions which externally mark the internal invaginations of the body

wall forming the anterior arms of the tentorium.

The compound eyes (e) which are large, semi-spherical and many faceted are dorso-lateral in position. They are a beautiful golden color in life, and very iridescent. There are two antennifers (anf) in each antennal socket. These are heavily sclerotized projections from the inner and outer ventro-lateral margins of the antennal sockets.

The antennae (Pl. I, fig. 3) are long, delicate, filiform appendages and are approximately three-fourths as long as the fore wings. They vary greatly as to the number of segments composing them. The first segment, or scape (scp), is flattened and much broader and longer than the other segments. The basal end is the broader and is colored dark brown. The second segment, or pedicle (pd), is dark brown in the central portion. It is slightly shorter than the scape; cylindrical and slightly constricted in the middle. The remaining segments form the flagellum (fl) and are encircled by four rows of setae. The third segment is not so broad or so long as the pedicle. The fourth segment is the shortest. The fifth and succeeding segments are subequal and are longer than the fourth, but are shorter than the third. The distal segments taper very slightly, the last being pointed at the apex.

The genae (ge), or cheeks, are the anterior portions of the latero-cephalic regions just behind and below

the compound eyes. The frontal sutures demark the frons from the genae. The genae are bounded anteriorly by the subgenal sutures (sgs). Postero-laterally they merge into the postgenae (pge) since no suture separates the two. The postgenal region is the cephalo-ventral surface of the head capsule on each side of the foramen.

The gula (gu) (Pl. II, fig. 10) is a sclerite in the postero-ventral portion of the head capsule and does not form a part of the skull. It is a narrow transverse plate with anteriorly directed arms, bearing the labium at its cephalic end.

The gular pits (gup) are located at the postero-lateral edges of the gula. These pits are external depressions marking the positions of the posterior arms of the tentorium.

The clypeus (cl) occupies about one-third of the frontal portion of the head capsule and extends from the labrum (lr) posteriorly to the epistomal suture. This suture is well marked and extends between the anterior ends of the frontal sutures, arching slightly in the middle. The latero-distal angles of the clypeus are rounded. Just above and parallel with the distal margin is a row of slight depressions, each containing a seta.

The labrum (lr) is a narrow, transverse sclerite with its apical margin arcuately concave, and its latero-distal angles are broadly rounded.

Tentorium (Pl. I, figs. 7, 8):- This is very well marked as a heavily sclerotized internal skeleton of the head. It is composed of the body of the tentorium (tnt), and three pairs of arms, namely, the anterior arms (at), the posterior arms (pt), and the dorsal arms (dt). Fig. 7 is a mesal view of the endoskeleton along its median axis and shows only one half of it.

One end of each anterior arm leads forward to the frontal pit; the other extends in a caudo-mesal direction, expanding along its mesal margin, then narrows for a distance and extends farther caudad until it finally fuses with the corresponding end of the other arm, forming a bridge (tnt) at its caudal extremity. From this bridge, or body of the tentorium, the two posterior arms extend laterally and posteriorly, leading back to the gular pits.

The dorsal arms are sclerotized, thread-like structures arising from the lateral margins of the anterior arms. They extend upward and become attached to the dorsal wall of the head capsule in the region of the antennae.

Mandibles (md) (Pl. I, fig. 4; Pl. II, figs. 11, 12):- These are well developed and fitted for crushing. They are pyramidal with three faces. The outer face, appearing as a continuation of the lateral aspect of the head, tapers mesally and joins with the other faces to terminate in an acute apex.

The inner margin of the right mandible (Pl. II, fig. 11) is convex in the basal region but is concave for

about one third of the distance to the apex. The basal portion of the convex area is the submola (smo). The anterior region of the convex and posterior of the concave margin is the mola (mo). The apical portion of the mesal edge is the incisor region (in).

The left mandible (Pl. II, fig. 12) differs from the right in that the basal portion of the inner margin gradually curves convexly and terminates in an acute tooth, the mola (mo), which is about midway between the base and apex of the mandible. From the mola the mesal edge extends laterally toward the outer surface, then turns and extends vertically for a short distance to the apex.

On the anterior face of each mandible a sharp edge runs dorsally for a short distance from the mid-submolar region parallel with the mesal edge, reverses its course for a short way, goes laterally toward the outer margin, turns and extends not quite parallel with the outer margin to the apex. On the anterior surface of each mandible is a brustia (br), or row of setae, which is adjacent to the submola and curves inward to the second turn of the edge just referred to.

The basal portion of each mandible is triangular in shape. Each mandible has two articulatory points for movement, the ginglymus (g) and condyle (c). The ginglymus is at the anterior end of the lateral edge. This is a depression, or socket, which fits over a condyle-like

projection in the latero-basal edge of the clypeus, forming a ball and socket articulation. The posterior end of the lateral edge bears a well developed condyle which fits into a socket in the latero-ventral margin of the postgena. There are two tendons to furnish movement of the mandibles. An extensor tendon (et) extending from the mid-portion of the basal edge of the lateral face to the head opens the mandible, while a flexor tendon (ft) from the meso-basal region of the mandible closes it.

At the base of each mandible may be seen a small U-shaped sclerite, the basimandibula (bm). If we are to accept the idea of Crampton (1921) in his study of the external anatomy of the head of insects, this plate was probably formed by a sclerotization of a part of the mandibular membrane between the base of the mandible and the head capsule.

Maxillae (mx) (Pl. I, fig. 4; Pl. II, fig. 9):-

The maxillae are ventrad of the mandibles. Each maxilla consists of five principal parts and two free portions. The primary parts are the cardo, stipes, palpifer, basigalea, and distigalea. The free portions are the lacinia and labial palp.

The cardo, or basal sclerite, is divided into the basicardo (bc) and disticardo (dc). The disticardo is long and quadrangular. The basicardo is smaller and has a convex anterior edge. The meso-basal portion of the disticardo bears a prominent articulatory condyle. The stipes (st) is a large subquadrangular sclerite forming the intermediate

portion of the maxilla. Two narrow strips, not demarked by distinct sutures, lie along the inner and outer margins of the stipes.

The palpifer (pfr) is on the latero-distal angle of the stipes. The maxillary palp (mp) is borne by the palpifer and is composed of five segments. The two basal segments are subequal in size, the second being the smaller, but shorter than the three terminal ones. These three are also subequal, the apical one being the longest and pointed at the tip.

The galea, or external lobe of the maxilla, is composed of two segments, the basigalea (bg) and distigalea (dg). According to Crampton (1923), the division of the galea into a basigalea and distigalea is a primitive survival that has been retained in the Neuroptera. The basigalea is the proximal U-shaped sclerite. The distigalea is much larger with the outer margin curving mesad. The apical region is clothed with hairs. The apical portion of the distigalea is not so heavily sclerotized as the rest of the sclerite.

The lacinia, or inner maxillary lobe, attached to the distal end of the stipes is mesad of the galea. It is composed of two parts, the basilacinia (bl) and distilacinia (la). The basilacinia is distad of the stipes, weakly sclerotized basally and more heavily sclerotized apically. The outer edge is sclerotized, giving a stiffening effect to the less heavily sclerotized distilacinia. The outer margin of the distilacinia sweeps downward and then upward

in a broad curve while the inner margin extends downward and then mesad, both margins terminating at the broad mesal edge. There is a small group of hairs on the posterior portion of the mesal edge.

Labium (Pl. II, fig. 10):- The basal sclerite of the labium is largely made up of the submentum (sm), although the posterior region of the basal sclerite contains the gular region (gu). The submentum has a broadly and sinuately incised anterior margin. In front of the submentum is a membranous area, which is bounded anteriorly by a convexly curved, narrow sclerite, the mentum (mn).

In front of the mentum is a small triangular region, the interlabium (il). The palpigers (pgr) are on each side of the interlabium, and the area between these and the interlabium is not so heavily sclerotized as the palpigers and interlabium. Each palpiger bears a three segmented labial palp (lp); the first segment is shortest, the second is longer, and the third is the longest and is pointed at the tip.

Anterior to the palpigers is a slightly sclerotized area which merges into a heavily sclerotized labiostipes (lst). The lateral margins of the labiostipes curve outwardly, making the distal end broader than the basal end. The glossae and paraglossae have fused and form a large membranous lobe (pg) surrounding the labiostipes. The distal edge of this lobe is truncate and the lateral edges are deflexed posteriorly.

Thorax and Its Appendages

The thorax bears the legs and wings and, because of this, great stress is brought upon it by the movement of these appendages. To allow for this stress some of the body wall is membranous, thus permitting its movement. The principal membranous regions are the cervix, prothoracic pleural region, intersegmental regions, and the regions at the articulation of the wings and legs. The apodemes are sclerotized internal ridges for muscle attachment.

There are two spiracles (sp) in the thorax, one in the mesothorax and one in the metathorax. The mesothoracic spiracle is situated in front of the mesopleuron. It is a slit-like opening in the body wall, surrounded by a rather oblong-shaped sclerite, the peritreme. The metathoracic spiracle is in front of the metapleuron. This is a circular aperture in the body wall, encircled by a sclerotized plate.

The papers of chief help in a study of the thorax and its appendages are those of Snodgrass (1909 and 1927) and Crampton (1909, 1914 and 1926). Martin's paper (1916) on the thoracic and cervical sclerites of insects is also of interest.

Cervix (Pl. III, fig. 16):- The cervix, or neck region, is membranous and contains three intersegmental plates, or cervicalia. The dorsal lateral cervicale (dlc) is

a medium-sized triangular plate in front of the pronotum. According to Crampton (1914), the dorsal lateral cervicale is probably a detached plate belonging to the segment in front of it.

There are two lateral cervical sclerites in the pleural region. The laterocervicale (lc), the largest of the cervical plates is ventrad of the dorsal cervicale. The postcervicale (poc) is a small, oblong sclerite postero-dorsad of the laterocervicale and appears cut out leaving a concavity into which the postcervicale may go when the head moves to one side.

Prothorax (Pl. III, fig. 16):- The prothorax appears as an elongated, depressed segment. The pronotum (pn) has a slight mesal depression, is broader than long, and is rounded at its anterior end.

Of the two pleural sclerites, the episternum (os), which is ventrad of the lateral edge of the pronotum, is an elongated sclerite narrowed anteriorly and broadened posteriorly. The anterior end is forked and the dorsal end of the postcervicale fits into the crotch. The epimeron (em), which is posterior to the episternum, is a narrow sclerite elongated in a dorso-ventral direction. The greater portion of the pleuron is membranous.

The basisternum (bs) is a large sclerite somewhat diamond-shaped with the posterior portion narrowed for a short distance and then broadened caudad, forming the furcasternum (fs).

There is no precoxal bridge uniting the sternal region with the pleural region. Crampton (1926) gives an excellent discussion of the precoxal bridge in Neuroptera. According to his theory, the absence of this bridge in Chrysopa perla gives a condition suggestive of the tendencies exhibited by the higher Holometabola.

Mesothorax (Pl. III, figs. 14, 16):- The tergum is divided into a pretergite, prescutum, scutum, scutellum, parascutellum, postergite, and postscutellum. The sutures separating the tergal sclerites are for the most part slightly depressed, giving an arched appearance to the sclerites.

A marginal sclerite (ms) which is anterior to the pretergite (prt) is probably a demarked portion of the tergum of the mesothorax. The pretergite is a narrow sclerite anterior to the prescutum (psc). The prescutum is a larger triangular arched plate laterally and posteriorly demarked from the scutum (sc) and mesally demarked from the pretergite on the other side. The scutum, the largest tergal plate, forms a broadly-rounded, elevated median lateral area and narrows in the dorso-median region. The lateral edges of the scutum are fused anteriorly with the prescutum and posteriorly with the scutellum (sl) and parascutellum (ps). Situated anteriorly and laterally, the scutum bears a rounded articulatory process, or suralare (l), with which the wing veins articulate by means of a small movable articulatory plate, the notopterales (ax). Behind the suralare is a slight indication of a weakly developed median

articulatory process (6). This median process extends toward the notopterale and forms a second anterior notal pivotal point for the wing. The scutellum is caudad of the scutum and is the second largest mesothoracic tergal sclerite. The scutum and scutellum are separated along the line of the internal V ridge which, according to Snodgrass (1909), is typical of the Neuroptera. Externally, no suture can be seen separating the scutellum from the parascutellum which is laterad of it. A narrow, posterior, marginal sclerite, the postergite (pot), which is raised on its lateral surface, bears at its antero-lateral edge an adanal process (2) which forms a posterior notal pivot for the wing. The posterior tergal sclerite, the postscutellum (psl), is connected with the pleural region and internally bears the phragma (pm) (fig. 14).

The basal alar region is a membranous area in which are seven sclerotized plates, or ossicles; namely, the tegula, notopterale, medials and basanals which are dorsal, and the intraalare, posterior basalar plate, and subalar plate which are ventral.

The tegula (tg) is a small triangular sclerite which is anteriorly located. The so-called first axillary, or notopterale (ax), is a slightly larger, somewhat triangular ossicle caudad of the anterior articulatory process, or suralare. According to Crampton (1928a), the notopterale is apparently a detached portion of the

lateral margin of the notal region. The notopterale is hinged by its inner margin to the edge of the tergum, with its anterior part supported by the suralare. It also articulates with the median process. The outer margin articulates with the medial plates (not figured) which Snodgrass (1927) believes may be derived from the proximal end of the radial vein with which they are continuous. The third axillary, or basanal (not figured), is the smallest and articulates with the posterior, or adanal wing process of the tergum. The outer edges of the basanal are associated with the bases of the anal veins.

Immediately dorsad of the anepisternum is the intraalare (not figured). The posterior basalar plate (aba) is ventrad of the suralare. The largest alar sclerite is the elongated subalar plate (sa) located ventrocaudad of the posterior basalar plate.

The pleuron of the mesothorax is divided into an anterior portion, the episternum, and a posterior portion, the epimeron. These in turn are subdivided into smaller sclerites.

The episternum and epimeron are separated by the pleural suture which extends from the pleural wing process, or alifer (o), to the pleural coxal process, or coxifer (5). Crampton (1909) applies the terms anepisternum (aes) and katepisternum (kes) to the upper and lower regions respectively of the episternum. These are separated by a narrow

strip which represents the median part of the episternum. Crampton (1914) brings forth the view that such a strip is probably part of the episternum which has become fused with the sternum to form a precoxal bridge. This whole region is designated as the mesosternum-(s). A division demarking the anepisternum is retained, but the region below it uniting with the sternum is not demarked from the latter. This composite region, called the sternopleura, is composed of the region below the anepisternum fused with the sternum. The posterior portion of the mesosternum together with the anterior portion of the katepisternum furnished an articulatory process (4) for the coxa. The katepisternum ventrally appears to bear the trochantin (tn) which is an elongated sclerite extending ventro-anteriorly. From an external view a true suture cannot be seen separating the katepisternum and trochantin, but an internal view of this shows clearly that such a suture is present. Crampton (1914) suggests that the trochantin may possibly be a detached sclerite of the pleural plate, though others suggest that it (and the pleural sclerites also) represents detached portions of the leg.

The epimeron which is posterior to the episternum is likewise divided into an upper region, the anepimeron (aem), and a lower region, the katepimeron (kem). These terms were proposed by Crampton (1909). The epimeron is not so

definitely subdivided as the episternum. A suture extends from the posterior edge in a ventro-anterior direction for a distance of about half the width of the epimeron, thus only partially subdividing it into its two parts. The anepimeron is much larger than the anepisternum and the katepimeron is much smaller than the katepisternum. The epimeron is more heavily sclerotized on its ventral and lateral edges. Dorsally, the anepimeron is deeply incised for the reception of the basalar and subalar plates. The dorso-anterior portion of the anepimeron which is the pleural fulcrum, or alifer, of the wing is slightly notched. The anepimeron also dorsally bears an articulatory process (3) for the posterior portion of the wing base.

The coxa of the mesothoracic leg is much larger than that of the prothoracic leg. It consists of a eucoxa (ecx) and a meron (me). The meron, which is well developed in Chrysopa perla, is a demarked posterior basal lobe of the coxa. The eucoxa is the larger and makes up the rest of the coxa. The coxa articulates with the coxal bearing process (4) and the coxifer (5).

Metathorax (Pl. III, figs. 15, 16):- The tergum is composed of a pretergite, prescutum, scutum, scutellum, parascutellum, postergite, and postscutellum.

Externally the marginal sclerite (ms), which is probably a demarked portion of the metathoracic tergum, and the pretergite (prt) are not seen when the parts are in their

natural position, but upon examination of the endoskeleton these can be plainly brought to view. The prescutum (psc) is a narrow sclerite which posteriorly fuses with the scutum (sc). The scutum is the largest tergal sclerite and appears to occupy the greater part of the metathoracic tergum as compared with the scutum of the mesothoracic tergum. Situated anteriorly and laterally, the scutum bears a rounded articulatory process, or suralare, (1) with which the wing veins articulate by means of a small movable articulatory ossicle, the notopterale (ax). Behind the suralare is a slight indication of a weakly developed median articulatory process (6). This process extends toward the notopterale and forms a second anterior notal pivot for the wing. The posterior tergal sclerite, the post-scutellum (psl) connects with the pleural region. The phragma (pm) is internally borne by the postscutellum.

The alar region of the metathorax is like that of the mesothorax. This membranous area has the seven following ossicles: the tegula, notopterale, medials and basanals which are dorsal, and the intraalare, posterior basalar plate and subalar plate which are ventral.

The tegula (tg) is a small anterior triangular sclerite, while the notopterale (ax) is a slightly larger, somewhat triangular ossicle caudad of the suralare. The notopterale on its inner margin articulates with the suralare and median process, and on its outer margin with the medial

plates (not figured) which are at the base of the radial vein. The smallest axillary, the basanal (not figured), is at the bases of the anal veins and articulates with the adanal wing process.

The intraalare (not figured) is dorsad of the anepisternum. Immediately ventrad of the suralare is the posterior basalar plate (pba). The elongated subalar plate (sa) is ventro-caudad of the posterior basalar plate.

The pleural region is divided into an episternum and epimeron which are separated by the pleural suture. This suture extends from the alifer (o), or pleural wing fulcrum, to the pleural coxal process, or coxifer (5).

In the episternum the upper portion, or anepisternum (aes), is separated from the lower portion, or katepisternum (kes), by an intermediate strip of the episternum which unites with the metasternum (s), similar to that separating the corresponding sclerites in the mesothorax.

As is the case in the mesothorax, the katepisternum ventrally appears to bear the trochantin (tn). The ental surface shows a clearly marked suture separating these. The posterior portion of the metasternum together with the anterior portion of the katepisternum furnished an articulatory process (4) for the coxa.

The metathorax differs from the mesothorax in that the division of the epimeron into its subregions, anepimeron (aem) and katepimeron (kem) is made by a complete suture whereas in the mesothorax the corresponding suture extends only half way across the epimeron. The metathoracic anepimeron

is smaller than the mesothoracic anepimeron, while the metathoracic katepimeron is larger than the mesothoracic katepimeron.

The postscutellum of the mesothorax which is continued posteriorly in the first abdominal tergite (lt) extends ventrally and encloses the first abdominal spiracle (sp). The region surrounding the spiracle unites with the metathoracic epimeron at the posterior end of the suture which divides it into two parts.

The metathoracic coxa is divided into two regions, a posterior basal lobe, the meron (me), and an anterior larger portion, the eucoxa (ecx).

Endoskeleton of the meso- and metathorax (Pl. II, fig. 13; Pl. III, figs. 14, 15):- The endoskeleton is composed of inwardly directed processes, or apodemes, which serve for muscle attachment and for the support of other viscera.

In the tergal region of the mesothorax (fig. 14) internal foldings, or ridges, can be seen demarking the various tergites. The infolding of the body wall along the median line between the marginal sclerites (ms) and prescutum (psc) of both sides forms an internal median ridge. The internal ridge demarking the scutellum and parascutellum (ps) is very prominent yet there is no indication of such a demarkation externally. This ridge is formed by the infolding of the body wall between the

scutellum and parascutellum. The postscutellum (psl) bears an internal lobe, the phragma (pm).

The metathoracic tergal region (fig. 15) shows no median ridge dividing the marginal sclerite and prescutum. There is a very distinct ridge separating the prescutum and scutum. The ridge demarking the scutum from the parascutellum is not as broad as the corresponding ridge in the mesothorax. The metathoracic phragma is small and ventrad of the postscutellum, while that of the mesothorax is large and caudad of the postscutellum.

In the pleural region an apodeme, the pleural ridge (pr), extends from the alifer (o), to the coxifer (5). This ridge is formed by an infolding of the body walls between the episternum and epimeron and is the largest apodeme in the endoskeleton. The pleural ridge gives off a pleural arm (pa) which extends to and fuses with the furcal arm, or furca (f) of the sternum. The pleural ridge serves as attachment for the muscles extending to the trochantin and coxa.

In the mesothorax, the epimeron is bounded posteriorly by a broad internal ridge, whereas there is no such ridge on the metathoracic epimeron. Both the meso- and metathoracic anepisterna bear an inner dorso-anterior plate.

The metathorax differs from the mesothorax in that the division of the epimeron into its subregions, anepimeron and katepimeron, is represented by a complete ridge whereas in the mesothorax the corresponding ridge extends only half

way across the epimeron. The trochantins (tn) of both the meso- and metathorax are distinct sclerites demarked from the katepimera.

The meso- and metasterna (s) in Figure 16 seen from within are made up of three parts, namely, the laterosternum, basisternum and furcasternum. The laterosternum (ls) unites ventro-mesally with the basisternum (bs), which in its median portion is rolled inward as a well defined ridge. The ridge separating the posterior region of the laterosternum from the anterior portion of the katepisternum is clearly demarked. The furcasternum (fs) is caudad of the basisternum and like it bears an internal apodeme. The furcasternum posteriorly extends into a furcal arm, or furca (f).

The position and shape of the phragma and furca of the mesothorax are shown in Figure 13.

Legs (Pl. II, figs. 5, 6):- The mesothoracic leg has been chosen for discussion but the marked differences between this and the other legs will be brought out.

The coxa, or proximal segment, has the appearance of a truncated cone. It is divided into a large anterior portion, the eucoxa (ecx), and a smaller demarked basal lobe, the meron (me). The meron never takes part in the trochanteral articulations (Snodgrass 1927). The coxa articulates with the coxal bearing process and coxifer of the mesopleuron. The distal end of the eucoxa bears three

articulatory processes (1, 2, 3) for the trochanter. The coxa of the prothoracic leg is much smaller and consists of two small elongated sclerites, the smaller anterior one being the eucoxa, and the larger posterior one, the meron.

The second segment of the leg is the trochanter (tr) which is a small quadrangular segment immovably joined to and sharply demarked from the femur (fe).

The femur and the following segment, the tibia (ti), are elongated cylindrical segments. The distal end of the tibia articulates with the tarsus (ta). On the ventral portion of the tibia at its distal end is a movable tibial spur (tis).

The tarsus is composed of five segments, the two terminal ones being the longest. The last tarsal segment, or distitarsus, bears the claws, or ungues (pta), and the arolium (ar). The ungues are hooked at the base and are connected ventro-basally with the sclerotized plate which is separated from the ventro-distal portion of the last tarsal segment by a membranous portion.

Ventrad of the distal portion of the distitarsus is a pad-like structure, the arolium. Two bristles extend dorso-distad from the membrane between the praetarsus and the last tarsal segment.

Wings (Pl. I, figs. 1, 2):- The venation of Chrysopa perla is highly specialized, and a correct interpretation of that of the adult can best be understood by first considering the pupal tracheation. However, as such a study was impossible in the time available for the preparation of the present thesis, the writer has adopted the conclusions of Tillyard (1916) and Smith (1922), who have described the wing venation of Chrysopa signata, Chrysopa nigricornis and Chrysopa oculata on the basis of the tracheation of the pupa.

The following quotation from Tillyard (1916) summarizes our present knowledge of the specialized venation in the family Chrysopidae:

"The solution shows us, indeed, that the wing-venation of the Chrysopidae is not only, as Petersen suspected, 'the most abnormal of all the families,' but that it is indeed one of the most abnormal and highly specialised venations to be found within the Insecta. Judged from this standpoint, the Chrysopidae stand far and away above all other Neuroptera in the effect and extent of their wing-specialisation."

The system of nomenclature here adopted is a combination of the Comstock-Needham and Tillyard interpretations. The tracing of the veins is in accordance with the views of Tillyard (1916), while the nomenclature of Comstock and Needham has been applied to the main veins. The cells are given the terms proposed by Tillyard.

Modification of Comstock-Needham
and Tillyard Systems

Costa	C	Tillyard Notation C. signata	Comstock-Needham Notation C. nericornis
Subcosta	Sc	Sc	Sc
Pterostigma	pt	pt	
Radius	R	R	R
1st radial	R1	R	R1
2d radial	R2	B1	
3d radial	R3	B2	R2a
4th radial	R4	B3	R3
5th radial	R5	B4	R4
6th radial	R6		R5
Radial sector	Rs	Rs	Rs R2 at the margin
Median	M	M	M
1st media	M1)	M1	M1
2d media	M2)		M2
3d media	M3	M2	M3
4th media	M4		M4
Pseudomedia	M1	M1	M1
Cubitus	Cu	Cu	Cu
1st cubitus	Cu1	Cu1	Cu1
2d cubitus	Cu2	Cu2	Cu2
1st anal	1A	1A	1A
2d anal	2A	2A	
3d anal	3A	3A	
Pseudocubitus	Cu1	Cu1	Cu1
Inner gradate series	g	g	
Outer gradate series	gl	gl	
Distal forks	df	df	
Posterior branches from radial sector	s1-s12	s	
Subcostal cross-vein	x	Sex	
Origin of radial sector	rf	rf	
Medial fork	mf	mf	
1st cubital fork	cuf	cuf	
2d cubital fork	cuf1	cuf1	

Modification of Comstock-Needham
and Tillyard Systems

Tillyard Notation

Comstock-Needham Notation

C. nigricornis

C. sphenata

Radial cell	r		
Upper series of Banksian cells	b	b	
Lower series of Banksian cells	b1	b1	
1st medial cell	m1	m1	
2d medial cell	m2	m2	
3d medial cell	m3	m3	
1st intramedial cell	e1	im1	
2d intramedial cell	e2	im2	
Cubital cell	Cu	Cu	
1st intracubital cell	u1	icul	
2d intracubital cell	u2	icu2	
3d intracubital cell	u3	icu3	
Posterior series of cells	p	p	

In the Chrysopidae the original media and cubitus have become reduced and contorted. The two resultant veins, the so-called pseudomedia and pseudocubitus, have become excessively complex and are peculiar to this family.

The costa (C) is the anterior marginal vein. The subcosta (Sc) appears to end beyond the pterostigma and near the tip of the wing. However, pupal tracheations of other species show that the subcosta ends at the inner border of the pterostigma, and in the adult the stigmal cross-veinlets have fused giving Sc the appearance of extending nearly to the wing tip. There are many veinlets between the costa and subcosta. The main cross-vein between the subcosta and radius is at (x) in the fore wing although there are a few cross-veins between the terminal portions of these main veins. The pterostigma (pt) is a membranous area between the costa and radius near the tip of the wing.

The radius (R) is a well-developed vein running parallel with the subcosta. The radial vein is forked as it reaches the margin. The radical sector (Rs) in the fore wing arises from the radius at the radial fork (rf), a considerable distance from the base of the wing; in the hind wing the origin is nearer the base. The radial sector gives off several posterior branches which vary in number. In the figure given these are s₁-s₁₂ in the fore wing and s₁-s₁₁ in the hind wing. The first seven in the fore wing and the first six in the hind wing extend straight to the margin.

The other five (R_2 , R_3 , R_4 , R_5 , R_6) are bent in their mid-portions and run longitudinally forming the distal portion of the pseudomedia (M^1). Four of these (R_3 , R_4 , R_5 , R_6) drop below the level of the pseudomedia, become bent again and run longitudinally forming the distal end of the pseudocubitus (Cu^1). Three of these (R_4 , R_5 , R_6) drop to the wing margin. It may be noted that R_1 , R_2 , R_3 , R_4 , R_5 and R_6 are two-branched at the wing margin. The fifth and sixth radial veins (R_5 and R_6) are often three-branched. The radial sector although often two-branched at the tip is usually unbranched.

The radial cell (r) is a simple cell lying between the main stems of R and M . The cells formed between the radial sector and pseudomedia by R_2 through R_6 inclusive are called the upper series of Banksian cells ($b-b$), and those formed below, between the pseudomedia and pseudocubitus by R_3 through R_6 inclusive are termed the lower series of Banksian cells ($bl-bl^1$). In the hind wing the first upper Banksian cell is that just distad of the triangular cell (t), which is really a rudiment of the first cell. This triangular cell is formed by R_5 , R_6 and M_{1+2} . In the twelve specimens at hand an excellent series of gradations, from a large triangular cell to no cell at all, were found. This decrease in size and final obliteration of the cell is due to the encroaching of the radial sector and sixth radial (R_6) vein on the media. The triangular cell, although absent in this particular specimen (No. 9) (fig. 2), has been drawn in

to show its general position.

The media (M) fuses basally with the radius for a distance, then diverges and runs to the median fork (mf) which in the fore wing is below and proximal of the radial fork, while in the hind wing it lies immediately below it. At the medial fork two branches (M_{1+2} and M_{3+4}) arise. In the fore wing, M_{1+2} arches upward while M_{3+4} extends concavely to it. M_{3+4} is then deflected cephalad and finally unites with M_{1+2} just beyond the radial cross-vein. These two elements then extend longitudinally for a short distance along the pseudomedia. M_{3+4} then drops down to the pseudocubitus, extends longitudinally and finally branches into M_3 and M_4 which reach the wing border. M_{1+2} extends further distad on the pseudomedia, drops to the pseudocubitus, runs distad and then branches into M_1 and M_2 which attain the border.

In the hind wing, M_{1+2} and M_{3+4} separate at the medial fork. M_{1+2} arches upward and comes close to the radial sector, then extends longitudinally along the pseudomedia and drops to the pseudocubitus. M_{3+4} extends parallel to and below M_{1+2} and meets this when it drops to the pseudocubitus. These two extend longitudinally a short distance, then M_{3+4} splits into its component parts, M_3 and M_4 , which drop to the wing border. M_{1+2} extends further distad and then breaks up into its component parts, M_1 and M_2 , which likewise extend to the margin. M_1 , although

usually simple, is often two-branched at the margin.

The cells formed by cross-veins between the media and cubitus are the medial cells. There are three (m_1 , m_2 , m_3) in the fore wing and two (m_1 , m_2) in the hind wing. Cells formed by the forking of M_{1+2} and M_{3+4} are the intra-medial cells (e_1 , e_2) in the fore wing. In the hind wing these are formed by a cross-vein dividing the large intramedial cell into its two component cells (e_1 , e_2).

The pseudomedia (M^1) in the fore wing arises from R near the base. It is formed by M up to mf, beyond this by M_{1+2} above e_1 , then by M_{1+2} and M_{3+4} united for half a cell's length, then by M_{1+2} and R_6 united for a short distance, then by R_6 , R_5 , R_4 , R_3 , R_2 overlapping each other in turn, and terminates in R_2 alone.

The cubitus (Cu) starts as a single vein basally. In the front wing it runs almost straight until it meets M_{3+4} as it drops onto the pseudocubitus. Cu_1 gives off three branches to the wing border. At the cubital fork (cf) which is proximal of the first cross-vein between the media and cubitus, one branch (Cu_2) is given off and swings down, soon sending two branches to the margin.

In the hind wing the cubitus branches at the first cubital fork (cf) which is closer to the base than it is in the fore wing. Cu_2 swings down and then as a single branch goes in a gentle curve to the margin. Cu_1 extends on a distance and again forks at the second cubital fork

(cf¹), one branch going to the margin, the other up to the pseudocubitus and finally dropping two branches to the margin. (In the figure shown, one branch is dotted to show that in this particular specimen no such branch is present. One specimen, No. 4, showed that this branch was becoming atrophied as two-thirds of it was entirely gone. The other ten specimens had two entire branches.)

The cubital cell (cu) is a simple cell lying between the main stems of the cubitus and first anal. There are two cross-veins between Cu₁ and Cu₂ in the fore wing forming three intracubital cells (u₁, u₂, u₃), and one in the hind wing forming two intracubital cells (u₁, u₂). In both wings there is a short cross-vein between Cu₂ and 1A just distad below the first cubital fork. In the hind wing, however, Cu₂ appears as part of 1A and the cross-vein in some cases is so short that these veins appear to adjoin each other.

The pseudocubitus (Cu¹) in the fore wing arises from the base of the wing and extends to cf as the main stem Cu. Beyond cf it is composed of Cu₁, M₄, M₃, M₂, M₁, R₆, R₅, R₄, R₃ overlapping each other in turn, and terminates in R₃ alone.

In the hind wing it arises near the base of the wing from R. It is formed by M for a short distance, then by M and Cu₁ united up to mf; beyond this by M₃₊₄ and Cu₁

united for over a cell's length, they by M_{3+4} , M_{1+2} , R_6 , R_5 , R_4 , R_3 overlapping each other in turn, and terminates in R_3 alone.

In both wings there are three anal veins. In the fore wing the first anal (1A) is two-branched, the second anal (2A) is also branched but the proximal branch unites with the third anal (3A). 3A is unbranched but has a double curvature causing it to come in contact with the margin of the wing between the base and the anal angle. A short cross-vein connects 1A with 2A.

In the hind wing all the anal veins are small and inconspicuous as compared with those in the fore wing. All are simple veins, but the third anal sends a small branch to the wing just proximad of the anal angle.

Two longitudinal series of cross-veins connect the posterior branches of R_s from s_1 to R_2 . The inner series is termed the inner gradate (g), and the outer series, the outer gradate (g^1).

The forks at the posterior end of the veins given off by the radial sector and the media are termed distal forks (df).

The cells between the proximal branch of Cu_1 and the proximal branch of R_2 are the posterior series of cells (p).

A few of the peculiarities present in the wings studied are as follows:

1. In specimens Nos. 1, 10 and 11. In both the fore and hind wings R_2 does not join the pseudomedia

until after R_3 has dropped down to the pseudocubitus. The pseudomedia thus consists of a cross-vein between R_3 and R_2 . Also a cross-vein has been added from R_2 to M^1 , appearing as one of the upper gradate series.

2. In specimen No. 12. In the fore wing a cross-vein is added between R_2 and M^1 .

3. In specimen No. 2. In the hind wing the median portion of s_8 has atrophied.

4. In specimen No. 3. In the fore wing s_8 extends to M^1 , the remaining portion having atrophied.

5. In specimens Nos. 1, 3, 5 and 12. In the fore wing of No. 3, hind wings of Nos. 1 and 5 and both wings of No. 12, the penultimate portion of R_3 has atrophied. In No. 3, an additional cross-vein has been added which connects the ultimate portion of R_3 and R_2 . Thus the average number of five lower Banksian cells is present. In Nos. 5 and 12, the cross-vein commonly between R_2 and R_3 connects R_3 with R_2 , and in No. 1 connects R_3 with M^1 . The portion of R_3 between M^1 and Cu^1 is still present. Thus only four lower Banksian cells are present.

6. In specimen No. 7. In the hind wing the portion of M_{1+2} between M^1 and Cu^1 has atrophied, making the second intramedial cell (e_2) longer than usual and reducing the number of lower Banksian cells to four.

7. In specimens Nos. 3, 4, and 9. In the hind wing of No. 4 there are two complete branches of Cu_1 and one about two-thirds atrophied. In Nos. 3 and 9, this

branch of Cu₁ that is on its way out in No. 4 has completely atrophied.

Tables I and II show in tabular form the number of main veins and cells in the twelve specimens of Chrysopa perla studied. The variation existing within the species is here graphically shown. The numbers opposite the veins represent the number of branches at the margin of the wing. The numbers opposite the cells represent the number of cells in the wing.

The numbers at the top of the sheet refer to the specimens as follows:

- No. 1. Sex? , Mondy, Sajan Mts., Siberia; determined by L. Navás
2. Female, Nowgorodow, Baikal, Siberia; determined by L. Navás
3. Male, Waldheim, Saxony, Germany; determined by L. Navás
4. Female, Linz, Austria
5. Female, Braunschweig, Germany
6. Female, Braunschweig, Germany
7. Female, Braunschweig, Germany
8. Female, Braunschweig, Germany
9. Male, Norway
10. Sex?, Norway
11. Sex?, Norway
12. Sex?, Norway

The right wings of specimens Nos. 1-10 inclusive and left wings of specimens Nos. 11 and 12 were studied.

- 4, 5, 6, 7, 8, through Staudinger and Bang-Haas
- 9, 10, 11, 12 through Dr. G. C. Crampton

From a study of this chart the following conclusions on the venation of Chrysopa perla have been drawn.

TABLE I.

Fore wings	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	Min.	Max.	Ave.
Third anal 3A	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Posterior branches from radial sector s	11	13	13	13	12	14	11	13	12	12	13	12	11	14	12
Inner gradate series g	5	6	6	7	6	8 ¹	5	6	5	5	6	5	5	8	5 6
Outer gradate series gl	6 ²	8	7	8	7 ²	9 ²	6	8	7	7	8	7	6	9	7
Distal forks df	10	9	13	12	11	12	10	11	8	9	10	8	8	12	10 12
Upper series of Banksian cells b	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Lower series of Banksian cells bl	5	5	5	5	5	5	5	5	5	5	5	4	4	5	5
Radial cell r	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Medial cell m	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Intramedial cells e	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Cubital cell Cu	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Intracubital cells u	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Posterior series of cells p	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16

1. One double, one Y.
2. One double.

TABLE II.

Hind limbs	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15	#16	#17	#18	#19	#20	#21	#22	#23	#24	#25	#26	#27	#28	#29	#30	#31	#32	#33	#34	#35	#36	#37	#38	#39	#40	#41	#42	#43	#44	#45	#46	#47	#48	#49	#50	#51	#52	#53	#54	#55	#56	#57	#58	#59	#60	#61	#62	#63	#64	#65	#66	#67	#68	#69	#70	#71	#72	#73	#74	#75	#76	#77	#78	#79	#80	#81	#82	#83	#84	#85	#86	#87	#88	#89	#90	#91	#92	#93	#94	#95	#96	#97	#98	#99	#100	#101	#102	#103	#104	#105	#106	#107	#108	#109	#110	#111	#112	#113	#114	#115	#116	#117	#118	#119	#120	#121	#122	#123	#124	#125	#126	#127	#128	#129	#130	#131	#132	#133	#134	#135	#136	#137	#138	#139	#140	#141	#142	#143	#144	#145	#146	#147	#148	#149	#150	#151	#152	#153	#154	#155	#156	#157	#158	#159	#160	#161	#162	#163	#164	#165	#166	#167	#168	#169	#170	#171	#172	#173	#174	#175	#176	#177	#178	#179	#180	#181	#182	#183	#184	#185	#186	#187	#188	#189	#190	#191	#192	#193	#194	#195	#196	#197	#198	#199	#200	#201	#202	#203	#204	#205	#206	#207	#208	#209	#210	#211	#212	#213	#214	#215	#216	#217	#218	#219	#220	#221	#222	#223	#224	#225	#226	#227	#228	#229	#230	#231	#232	#233	#234	#235	#236	#237	#238	#239	#240	#241	#242	#243	#244	#245	#246	#247	#248	#249	#250	#251	#252	#253	#254	#255	#256	#257	#258	#259	#260	#261	#262	#263	#264	#265	#266	#267	#268	#269	#270	#271	#272	#273	#274	#275	#276	#277	#278	#279	#280	#281	#282	#283	#284	#285	#286	#287	#288	#289	#290	#291	#292	#293	#294	#295	#296	#297	#298	#299	#300	#301	#302	#303	#304	#305	#306	#307	#308	#309	#310	#311	#312	#313	#314	#315	#316	#317	#318	#319	#320	#321	#322	#323	#324	#325	#326	#327	#328	#329	#330	#331	#332	#333	#334	#335	#336	#337	#338	#339	#340	#341	#342	#343	#344	#345	#346	#347	#348	#349	#350	#351	#352	#353	#354	#355	#356	#357	#358	#359	#360	#361	#362	#363	#364	#365	#366	#367	#368	#369	#370	#371	#372	#373	#374	#375	#376	#377	#378	#379	#380	#381	#382	#383	#384	#385	#386	#387	#388	#389	#390	#391	#392	#393	#394	#395	#396	#397	#398	#399	#400	#401	#402	#403	#404	#405	#406	#407	#408	#409	#410	#411	#412	#413	#414	#415	#416	#417	#418	#419	#420	#421	#422	#423	#424	#425	#426	#427	#428	#429	#430	#431	#432	#433	#434	#435	#436	#437	#438	#439	#440	#441	#442	#443	#444	#445	#446	#447	#448	#449	#450	#451	#452	#453	#454	#455	#456	#457	#458	#459	#460	#461	#462	#463	#464	#465	#466	#467	#468	#469	#470	#471	#472	#473	#474	#475	#476	#477	#478	#479	#480	#481	#482	#483	#484	#485	#486	#487	#488	#489	#490	#491	#492	#493	#494	#495	#496	#497	#498	#499	#500	#501	#502	#503	#504	#505	#506	#507	#508	#509	#510	#511	#512	#513	#514	#515	#516	#517	#518	#519	#520	#521	#522	#523	#524	#525	#526	#527	#528	#529	#530	#531	#532	#533	#534	#535	#536	#537	#538	#539	#540	#541	#542	#543	#544	#545	#546	#547	#548	#549	#550	#551	#552	#553	#554	#555	#556	#557	#558	#559	#560	#561	#562	#563	#564	#565	#566	#567	#568	#569	#570	#571	#572	#573	#574	#575	#576	#577	#578	#579	#580	#581	#582	#583	#584	#585	#586	#587	#588	#589	#590	#591	#592	#593	#594	#595	#596	#597	#598	#599	#600	#601	#602	#603	#604	#605	#606	#607	#608	#609	#610	#611	#612	#613	#614	#615	#616	#617	#618	#619	#620	#621	#622	#623	#624	#625	#626	#627	#628	#629	#630	#631	#632	#633	#634	#635	#636	#637	#638	#639	#640	#641	#642	#643	#644	#645	#646	#647	#648	#649	#650	#651	#652	#653	#654	#655	#656	#657	#658	#659	#660	#661	#662	#663	#664	#665	#666	#667	#668	#669	#670	#671	#672	#673	#674	#675	#676	#677	#678	#679	#680	#681	#682	#683	#684	#685	#686	#687	#688	#689	#690	#691	#692	#693	#694	#695	#696	#697	#698	#699	#700	#701	#702	#703	#704	#705	#706	#707	#708	#709	#710	#711	#712	#713	#714	#715	#716	#717	#718	#719	#720	#721	#722	#723	#724	#725	#726	#727	#728	#729	#730	#731	#732	#733	#734	#735	#736	#737	#738	#739	#740	#741	#742	#743	#744	#745	#746	#747	#748	#749	#750	#751	#752	#753	#754	#755	#756	#757	#758	#759	#760	#761	#762	#763	#764	#765	#766	#767	#768	#769	#770	#771	#772	#773	#774	#775	#776	#777	#778	#779	#780	#781	#782	#783	#784	#785	#786	#787	#788	#789	#790	#791	#792	#793	#794	#795	#796	#797	#798	#799	#800	#801	#802	#803	#804	#805	#806	#807	#808	#809	#810	#811	#812	#813	#814	#815	#816	#817	#818	#819	#820	#821	#822	#823	#824	#825	#826	#827	#828	#829	#830	#831	#832	#833	#834	#835	#836	#837	#838	#839	#840	#841	#842	#843	#844	#845	#846	#847	#848	#849	#850	#851	#852	#853	#854	#855	#856	#857	#858	#859	#860	#861	#862	#863	#864	#865	#866	#867	#868	#869	#870	#871	#872	#873	#874	#875	#876	#877	#878	#879	#880	#881	#882	#883	#884	#885	#886	#887	#888	#889	#890	#891	#892	#893	#894	#895	#896	#897	#898	#899	#900	#901	#902	#903	#904	#905	#906	#907	#908	#909	#910	#911	#912	#913	#914	#915	#916	#917	#918	#919	#920	#921	#922	#923	#924	#925	#926	#927	#928	#929	#930	#931	#932	#933	#934	#935	#936	#937	#938	#939	#940	#941	#942	#943	#944	#945	#946	#947	#948	#949	#950	#951	#952	#953	#954	#955	#956	#957	#958	#959	#960	#961	#962	#963	#964	#965	#966	#967	#968	#969	#970	#971	#972	#973	#974	#975	#976	#977	#978	#979	#980	#981	#982	#983	#984	#985	#986	#987	#988	#989	#990	#991	#992	#993	#994	#995	#996	#997	#998	#999	#1000	#1001	#1002	#1003	#1004	#1005	#1006	#1007	#1008	#1009	#1010	#1011	#1012	#1013	#1014	#1015	#1016	#1017	#1018	#1019	#1020	#1021	#1022	#1023	#1024	#1025	#1026	#1027	#1028	#1029	#1030	#1031	#1032	#1033	#1034	#1035	#1036	#1037	#1038	#1039	#1040	#1041	#1042	#1043	#1044	#1045	#1046	#1047	#1048	#1049	#1050	#1051	#1052	#1053	#1054	#1055	#1056	#1057	#1058	#1059	#1060	#1061	#1062	#1063	#1064	#1065	#1066	#1067	#1068	#1069	#1070	#1071	#1072	#1073	#1074	#1075	#1076	#1077	#1078	#1079	#1080	#1081	#1082	#1083	#1084	#1085	#1086	#1087	#1088	#1089	#1090	#1091	#1092	#1093	#1094	#1095	#1096	#1097	#1098	#1099	#1100	#1101	#1102	#1103	#1104	#1105	#1106	#1107	#1108	#1109	#1110	#1111	#1112	#1113	#1114	#1115	#1116	#1117	#1118	#1119	#1120	#1121	#1122	#1123	#1124	#1125	#1126	#1127	#1128	#1129	#1130	#1131	#1132	#1133	#1134	#1135	#1136	#1137	#1138	#1139	#1140	#1141	#1142	#1143	#1144	#1145	#1146	#1147	#1148	#1149	#1150	#1151	#1152	#1153	#1154	#1155	#1156	#1157	#1158	#1159	#1160	#1161	#1162	#1163	#1164	#1165	#1166	#1167	#1168	#1169	#1170	#1171	#1172	#1173	#1174	#1175	#1176	#1177	#1178	#1179	#1180	#1181	#1182	#1183	#1184	#1185	#1186	#1187	#1188	#1189	#1190	#1191	#1192	#1193	#1194	#1195	#1196	#1197	#1198	#1199	#1200	#1201	#1202	#1203	#1204	#1205	#1206	#1207	#1208	#1209	#1210	#1211	#1212	#1213	#1214	#1215	#1216	#1217	#1218	#1219	#1220	#1221	#1222	#1223	#1224	#1225	#1226	#1227	#1228	#1229	#1230	#1231	#1232	#1233	#1234	#1235	#1236	#1237	#1238	#1239	#1240	#1241	#1242	#1243	#1244	#1245	#1246	#1247	#1248	#1249	#1250	#1251	#1252	#1253	#1254	#1255	#1256	#1257	#1258	#1259	#1260	#1261	#1262	#1263	#1264	#1265	#1266	#1267	#1268	#1269	#1270	#1271	#1272	#1273	#1274	#1275	#1276	#1277	#1278	#1279	#1280	#1281	#1282	#1283	#1284	#1285	#1286	#1287	#1288	#1289	#1290	#1291	#1292	#1293	#1294	#1295	#1296	#1297	#1298	#1299	#1300	#1301	#1302	#1303	#1304	#1305	#1306	#1307	#1308	#1309	#1310	#1311	#1312	#1313	#1314	#1315	#1316	#1317	#1318	#1319	#1320	#1321	#1322	#1323	#1324	#1325	#1326	#1327	#1328	#1329	#1330	#1331	#1332	#1333	#1334	#1335	#1336	#1337	#1338	#1339	#1340	#1341	#1342	#1343	#1344	#1345	#1346	#1347	#1348	#1349	#1350	#1351	#1352	#1353	#1354	#1355	#1356	#1357	#1358	#1359	#1360	#1361	#1362	#1363	#1364	#1365	#1366	#1367	#1368	#1369	#1370	#1371	#1372	#1373	#1374	#1375	#1376	#1377	#1378	#1379	#1380	#1381	#1382	#1383	#1384	#1385	#1386	#1387	#1388	#1389	#1390	#1391	#1392	#1393	#1394	#1395	#1396	#1397	#1398	#1399	#1400	#1401	#1402	#1403	#1404	#1405	#1406	#1407	#1408	#1409	#1410	#1411	#1412	#1413	#1414	#1415	#1416	#1417	#1418	#1419	#1420	#1421	#1422	#1423	#1424	#1425	#1426	#1427	#1428	#1429	#1430	#1431	#1432	#1433	#1434	#1435	#1436	#1437	#1438	#1439	#1440	#1441	#1442	#1443	#1444	#1445	#1446	#1447	#1448	#1449	#1450	#1451	#1452	#1453	#1454	#1455	#1456	#1457	#1458	#1459	#1460	#1461	#1462	#1463	#1464	#1465	#1466	#1467	#1468	#1469	#1470	#1471	#1472	#1473	#1474	#1475	#1476	#1477	#1478	#1479	#1480	#1481	#1482	#1483	#1484	#1485	#1486	#1487	#148
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1. Veins found to be constant:

A. In both the fore and hind wings the following are present.

Costa

Subcosta

6 Radial veins

Radial sector

4 Medial veins

2 Cubital veins

3 Anal veins

B. Veins in both the fore and hind wings with constant number of marginal branches.

Veins	Number of marginal branches	
	Fore Wing	Hind Wing
R ₁	2	2
R ₂	2	2
R ₃	2	2
R ₄	2	2
M ₂	1	1
M ₃	1	1
M ₄	1	1
Cu ₁	3	variable
Cu ₂	2	1
1A	2	1
2A	1	1
3A	1	1

2. Cells found to be constant:

A. Cells in both the fore and hind wings.

Cells	Number of cells	
	Fore wing	Hind wing
Upper series of Banksian cells ..	5	4
Radial cell	1	1
Medial cell	3	2
Intramedial cell	2	2
Cubital cell	1	1
Intracubital cell	3	2
Posterior series of cells	16	variable

It may be noted that in both the fore and hind wings great variation occurs in the number of inner and outer gradates and in the number of posterior branches from the radial sector. There is also variation in the number of branches borne by R₅, R₆ and M₁; if one is three-branched, the other two are two-branched.

Tillyard (1916) in discussing the wing venation of the Chrysopidae lists a few venational differences on which he considers sound species of Chrysopa may be based. From the present study of the venation of Chrysopa perla, some of the characters listed by Tillyard are found to vary greatly within the species and so may be considered as being of doubtful value for specific purposes. These doubtful characters are as follows:

1. Number of free sectors; number of cells between R and Rs.
2. Number of closed cells beyond the arculus (proximal portion of the first intramedial cell) in the space between M^1 and Cu^1 in the fore wing; the number of same beyond mf in the hind wing.
3. Number of distal forks (df): the number of simple posterior cells (p) before the most proximal distal fork.
4. Number of gradate veins in both the inner and outer series.

Abdomen and Its Appendages

The abdomen (Pl. IV, figs. 17, 18, 19, 20, 21, 22) is composed of eight distinct spiracle-bearing segments followed by a ninth which is highly modified as the genital segment. The terminal segments are so indistinguishably united it is impossible to determine them.

The dorsum has a series of nine tergites (1t-9t). The first abdominal tergite (1t) is short and the anterior portion extends ventrally into the pleural region and bears the first abdominal spiracle (sp). The region surrounding the spiracle is connected with the metathorax by an extension of the metathoracic epimeron. Tergites two to seven inclusive are approximately equal in length. The second tergite (2t) is distinctly divided into two plates

while the five following tergites show only a slight tendency toward division. Tergites two to eight inclusive of the male and two to seven inclusive of the female are subequal. The eighth tergite (8t) of the female is short.

The pleuron, or the membranous region between the tergites and sternites, is very distinct in Chrysopa perla. The spiracles (sp) are small semi-circular openings and are found in the first eight pleurites.

The ventral region has a series of seven sternites in the female (figs. 17, 19) and eight in the male (figs. 20, 22). The first sternite (1s) is short and, from its postero-dorsal region, a sclerotized rod extends dorso-cephalad into the pleural region. Ventrad of this rod another rod not connected with the sternite extends parallel to it. Sternites two to seven inclusive are subequal. The eighth sternite of the male is about half the size of the seventh.

Female Genitalia (figs. 17, 18, 19):- The ninth tergite has apparently been retained and extends ventrad to form the valves (Pariser 1919). In Chrysopa vulgaris (Pariser 1919), the ninth tergite shows no secondary division cephalad of the sensory area (a). However, Chrysopa perla has a distinct suture in the lateral region, which is continued dorsad in some as a very faint suture and in others as a very distinct suture. This would seem to indicate that the ninth tergite has become secondarily divided into an

anterior and posterior region. Crampton (1929) calls this posterior area in Raphidia notata the tenth tergite.

Stitz (1909) shows the female of Chrysopa perla (Taf 29, fig. 131) as having a transverse suture dividing the ninth segment into an upper and lower region. Pariser (1919) calls attention to this error. The specimens studied by the writer check with Pariser's observations.

Caudo-ventrad of the valves is a sclerotized area in the mid region of which is a slit-like genital opening, or gonopore (gp). Pariser (1919) calls this region the cover plate. Crampton (1929) in figuring Corydalis cornuta indicates the possibility that the ventral portion of the ninth tergite may be the proximal portion of the dorsal valve and the cover plate of Pariser the distal portion of the dorsal valve. A membranous protuberance, which in Corydalis cornuta (Crampton 1929) is termed the proctiger, is dorsad of the cover plate. The anus (an) opens dorsally on the proctiger.

Male Genitalia (figs. 20, 21, 22):- The ninth tergite extends cephalo-ventrad. Pariser (1919) in figuring Chrysopa vulgaris terms this cephalo-ventral portion the valve. Crampton (1920) calls the corresponding portion of Nymphes myrmelionides the gonopleurite, and the dorsal portion containing the sense areas (a) the surgonopod. There is an elongated ventral plate which is probably the ninth sternite. Crampton (1918a) terms the corresponding sternite

of Corydalis cornutus the hypandrium, or subgenital valve. The lobe-like structure (b) caudad of the subgenital valve is apparently the sublaminae (Crampton 1918a). A large membranous genital swelling extends caudad from between the gonopleurite and subgenital valve. On this swelling are three light gray areas (k).

The male genitalia of Chrysopa perla figured by Stitz (1909) (Taf. 26, fig. 41) is entirely different from the one figured in this thesis. The specimens used by the writer were compared and found to check with a male determined by Navás as Chrysopa perla. This leads the writer to believe that the male genitalia figured by Stitz is that of another species.

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ABBREVIATIONS

a - sense area
aba - posterior basalar plate
aem - anepimeron
aes - anepisternum
an - anus
anf - antennifer
ar - arolium
as - antennal socket
at - anterior arm of tentorium
ax - notopterales

b - lobed portion on male genitalia
bc - basicardo
bg - basigalea
bl - basilacinia
bm - basimandibula
br - brustia
bs - basisternum

c - condyle
cd - cardo
cl - clypeus

dc - disticardo
dg - distigalea
dlc - dorsal lateral cervicale
dt - dorsal arm of tentorium

e - eye

ecx - eucoxa

em - epimeron

es - episternum

esu - epistomal suture

et - extensor tendon

f - furca

fe - femur

fl - flagellum

for - occipital foramen

fr - frons

frp - frontal pit

fs - furcasternum

fsu - frontal suture

ft - flexor tendon

.

g - ginglymus

ge - gena

gp - gonopore

gu - gula

gup - gula pit

il - interlabium

in - incisor region

k - light spot on male genitalia

kem - katepimeron

kes - katepisternum

la - distilacinia

lc - laterocervicale

li - labium

lp - labial palp

lr - labrum

ls - laterosternum

lst - labiostipes

md - mandible

me - meron

mn - mentum

mo - mola

mp - maxillary palp

ms - marginal sclerite

mx - maxilla

o - alifer

ocp - occiput

os - occipital suture

p - pleurite

pa - pleural arm

pba - posterior basalar plate

pd - pedicle

pfr - palpifer

pg - fused glossae and paraglossae

pgr - palpiger
pm - phragma
pn - pronotum
poc - postcervicale
pot - postergite
pr - pleural ridge
prt - pretergite
ps - parascutellum
psc - prescutum
psl - postscutellum
pt - posterior arm of tentorium
pta - unguis

s - sternite
sa - subalar plate
sc - scutum
scp - scape
sgs - subgenal suture
sl - scutellum
sm - submentum
smo - submola
sp - spiracle
st - stipes

t - tergite
ta - tarsus
tg - tegula

ti - tibia

tis - tibial spur

tn - trochantin

tnt - body of tentorium

tr - trochanter

ts - temporal suture

v - vertex

1, 2, 3, 4, 5, 6 - articular processes

In Plate I.

1, 2, 3 - articular processes for trochanter

In Plate III.

1 - suralare

2 - adanal process

3 - articular process for wing

4 - articular process for coxa

5 - coxifer

6 - median articular process

Veins

C - costa

Sc - subcosta

R - radius

R₁ - 1st branch of radius

R₂ - 2d branch of radius

R₃ - 3d branch of radius

R₄ - 4th branch of radius

R₅ - 5th branch of radius

R₆ - 6th branch of radius

Rs - radial sector

M - media

M₁ - 1st branch of media

M₂ - 2d branch of media

M₃ - 3d branch of media

M₄ - 4th branch of media

M¹ - pseudomedia

Cu - cubitus

Cu₁ - 1st branch of cubitus

Cu₂ - 2d branch of cubitus

Cu¹ - pseudocubitus

1A - 1st anal

2A - 2d anal

3A - 3d anal

s₁ - 1st posterior branch from radial sector

s₇ - 7th posterior branch from radial sector

s₁₁ - 11th posterior branch from radial sector

s₁₂ - 12th posterior branch from radial sector

cuf - 1st cubital fork

cuf¹ - 2d cubital fork

df - distal fork

mf - medial fork

rf - radial fork

g - inner gradate series of veins

g¹ - outer gradate series of veins

b-b - upper series of Banksian cells
bl-bl¹ - lower series of Banksian cells
r - radial cell
e₁ - 1st intramedial cell
e₂ - 2d intramedial cell
m₁ - 1st medial cell
m₂ - 2d medial cell
m₃ - 3d medial cell
cu - cubital cell
u₁ - 1st intracubital cell
u₂ - 2d intracubital cell
u₃ - 3d intracubital cell
p-p - posterior series of cells
t - triangular cell
pt - pterostigma

EXPLANATION OF PLATES

Plate I

- Fig. 1.- Right fore wing of male.
2.- Right hind wing of male.
3.- Antenna.
4.- Head, frontal aspect.
5.- Left mesothoracic leg of female, anterior aspect.
6.- Left mesothoracic tarsus and distal end of tibia
of female, ventral aspect.
7.- Tentorium, mesal view along the median axis.
8.- Tentorium, caudal aspect.

Plate II

- Fig. 9.- Left maxilla, posterior aspect.
10.- Labium, posterior aspect.
11.- Right mandible, anterior aspect.
12.- Left mandible, anterior aspect.
13.- Mesothorax, caudal aspect.

Plate III

- Fig. 14.- Mesothoracic endoskeleton, lateral aspect.
15.- Metathoracic endoskeleton, lateral aspect.
16.- Thorax, lateral aspect.

Plate IV

- Fig. 17.- Abdomen of female, lateral aspect.
- 18.- Genitalia of female, dorsal aspect.
- 19.- Genitalia of female, ventral aspect.
- 20.- Caudal portion of abdomen of male, lateral aspect.
- 21.- Genitalia of male, dorsal aspect.
- 22.- Genitalia of male, ventral aspect.

PLATE I

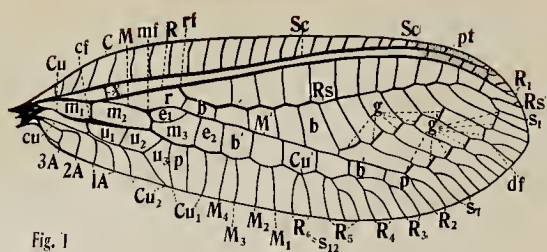


Fig. 1

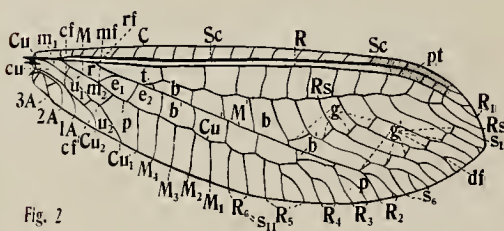


Fig. 2

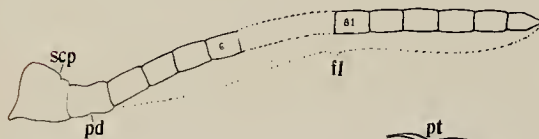


Fig. 3

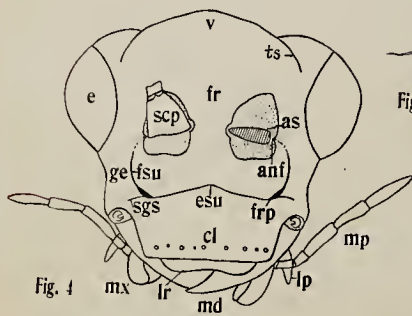


Fig. 4



Fig. 7

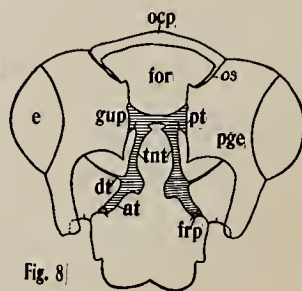


Fig. 8

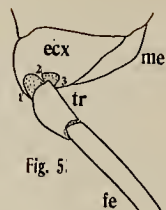


Fig. 5

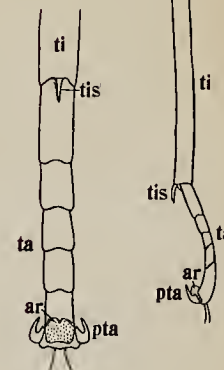


Fig. 6

PLATE II

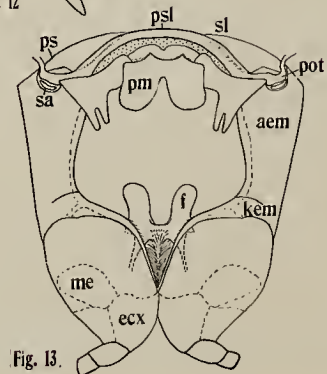
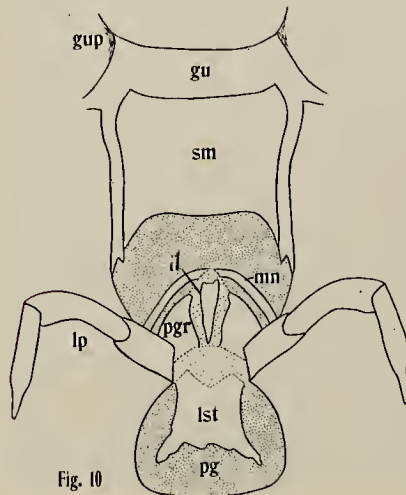
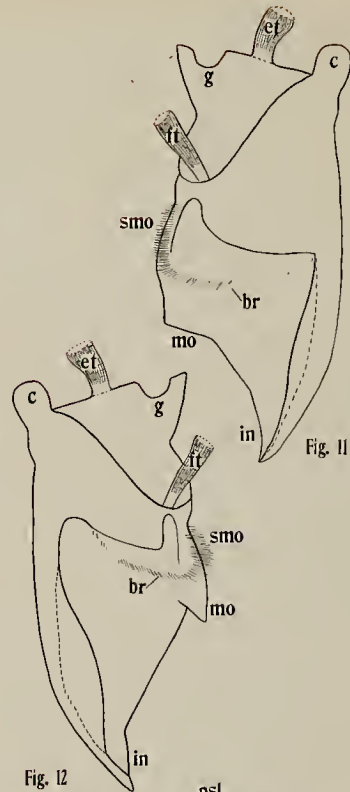
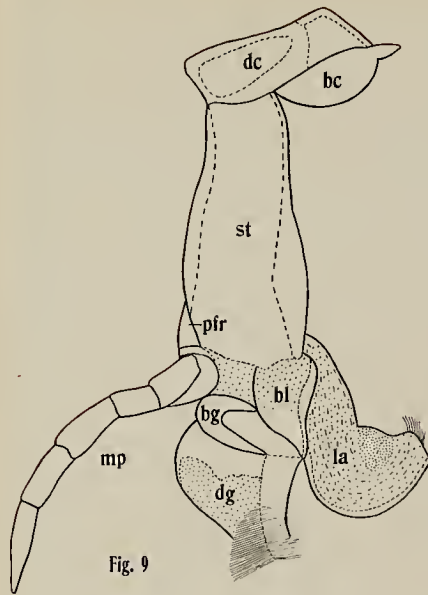


PLATE III

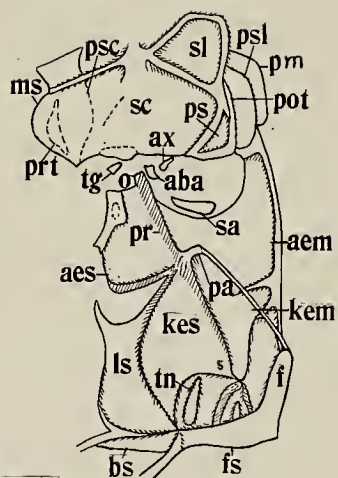


Fig. 14

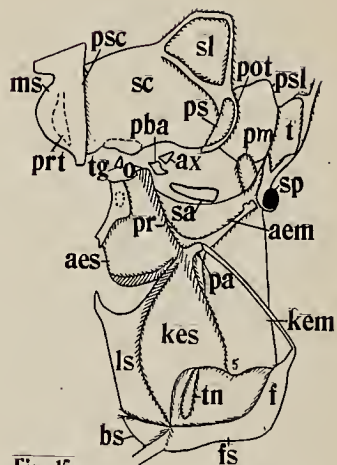


Fig. 15

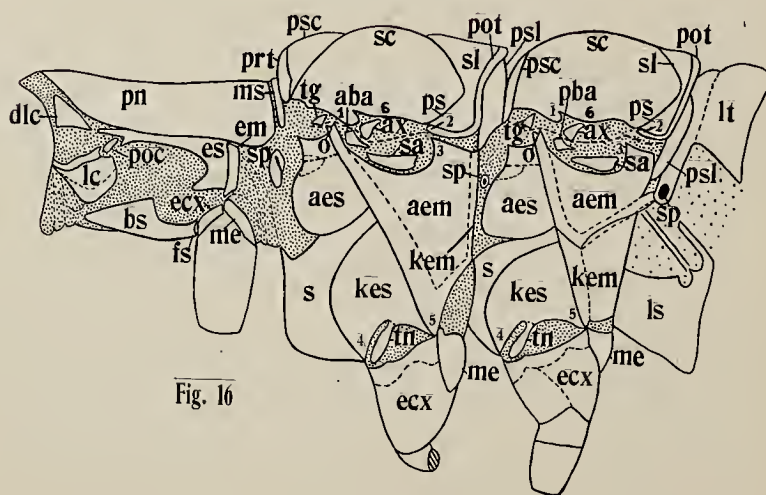


Fig. 16

PLATE IV

